Space Weather Technical Forecast

Issued on Wednesday, 20 December 2023 at 13:21 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity is Low, with the peak flare a C8.4 event at 20/0854 UTC from AR3521. Ten sunspot regions feature on the visible disc, with two unnumbered regions recently rotated around the eastern limb, whilst AR3524 and AR3525 have faded to plage. AR3529 in the southeast is the largest spot on the disk, with continued development of both the large asymmetric leader spot and the trailing portion, now showing a beta-gamma magnetic configuration. AR3528 in the northwest is the second largest region, also exhibiting a beta-gamma magnetic structure. AR3521 in the northeast continues to develop, with some complexity to the polarity of the small intermediate spots, so a beta-gamma classification is also given to the region. The remaining regions are all smaller or magnetically simple.

No Earth-directed CMEs have been observed in coronagraph imagery.

Solar Wind / Geomagnetic Activity: The solar wind environment was characterised the waning effects of a connection to the high-speed stream of coronal hole 82, with a glancing blow of a weak CME from 15 Dec. Solar wind as measured by ACE at L1 declined from strong to slightly elevated levels, around 620 to 450 km/s. Density was predominantly below average. The IMF was weak throughout, but jumped to 8nT at 20/0030 UTC. The north-south component of the IMF varied weakly, though with a notable change after 20/0030 UTC to +6/-7nT with a sustained period at -Bz. The phi angle was mostly positive (away from the Sun), but was negative (towards the Sun) between 19/1400-19/2000 UTC. Resultant geomagnetic activity was largely Quiet to Unsettled (Kp 1-3), but with an Active (Kp4) interval from 20/0000-0300 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was mostly at normal background to moderate levels. The 24-hour fluence was well below the Active threshold (1e8 integrated pfu) on a slight rising trend. The observation at 20/0000 UTC was 1.46e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low with a chance of becoming Moderate with isolated M-class flares.

Solar Wind / Geomagnetic Activity: No Earth directed CMEs feature in the forecast. The Earth is currently connected to the HSS of CH82/+. Speeds should slowly ease back to slightly elevated, or slow ambient through days 1 and 2 (20-21 Dec). The next potential HSS enhancement is from CH83/- on day 2 (21 Dec) or day 3 (22 Dec). Speeds could peak between slightly elevated and strong levels. From day 4 (23 Dec), winds should trend back towards background levels.

Geomagnetic activity should remain largely Quiet to Unsettled during the period. There is a chance of peak Active conditions and a slight chance of a G1/Minor storm interval upon the arrival of the high speed stream of CH83/- days 2 or 3 (21/22 Dec).

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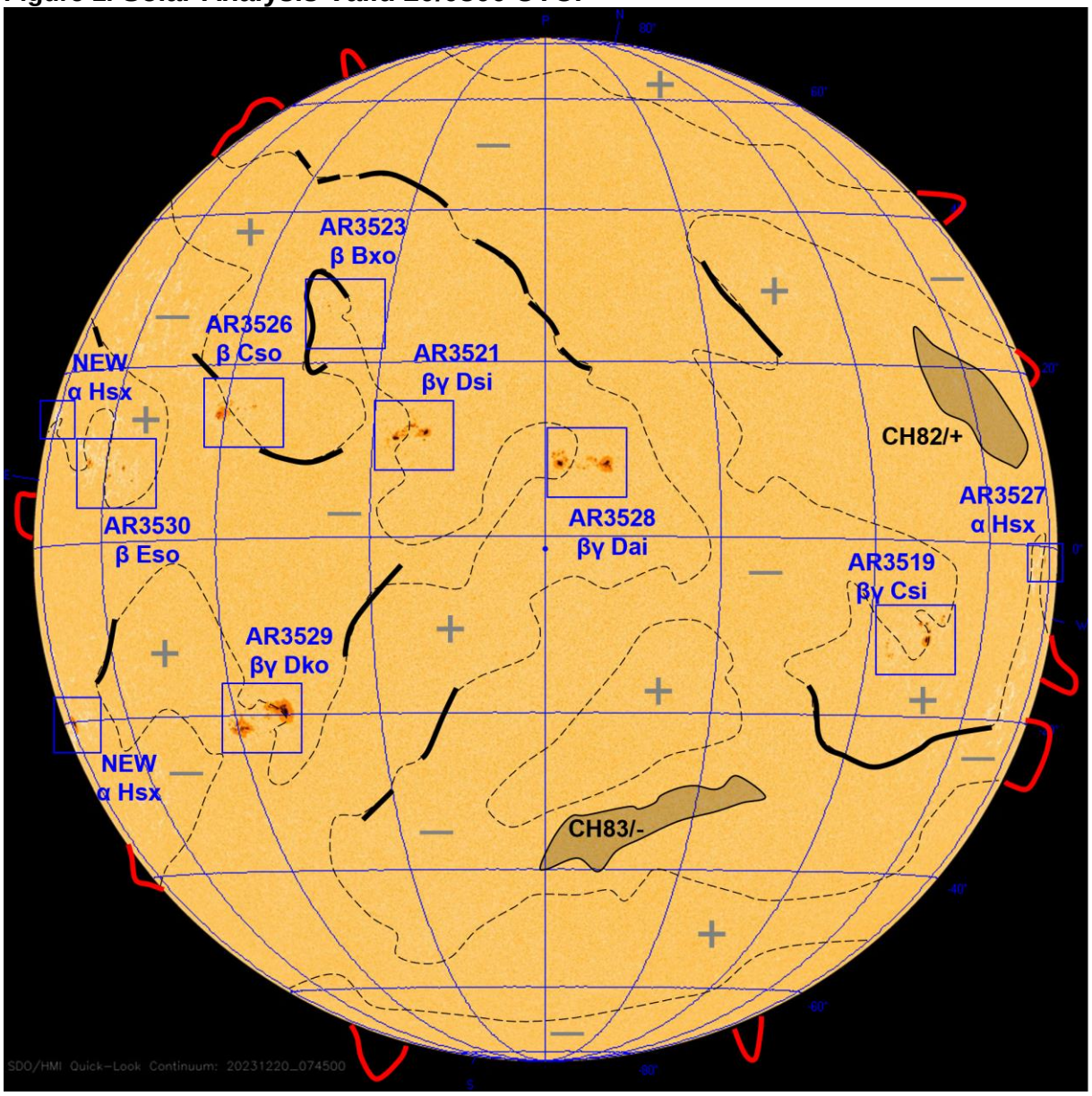
Met Office Space Weather Technical Forecast

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is at Background levels and expected to remain at similar levels.

High energy electron flux is predominantly at normal background levels. Daily High electron levels may be achieved from day 2 (20 Dec) onwards and may reach more persistently High levels on subsequent days, although this depends strongly on the potential arrival of the high-speed stream from coronal hole 83 that could suppress electron counts again. Thus, Active electron fluence is considered very unlikely throughout, but with confidence becoming low from day 3 (22 Dec) onward.

Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth directed CMEs feature in the forecast.

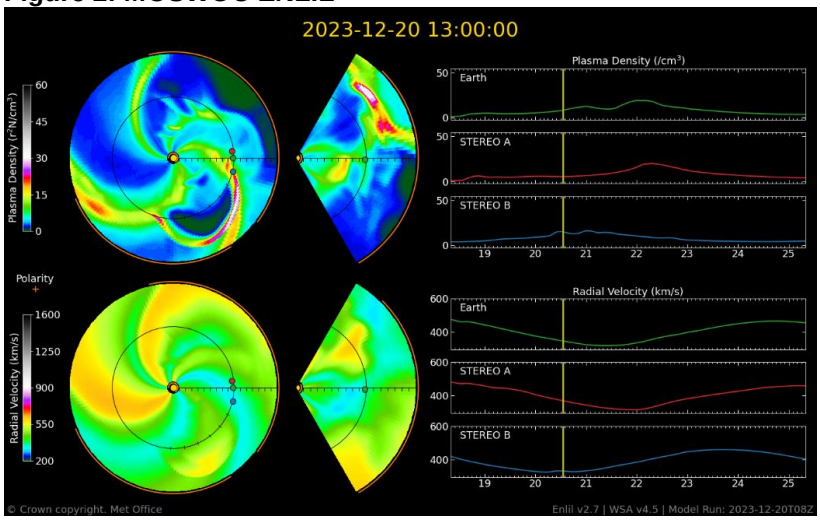
Enhanced solar winds from CH82/+ are currently at elevated levels (around 500 km/s). Speeds should slowly ease back to slightly elevated, or slow ambient through days 1 and 2 (20-21 Dec). The next potential HSS enhancement is from CH83/-. This is a recurrent feature, though appears larger and darker than previous rotation and may become geo-effective in the coming days, with the earliest reasonable arrival time from the middle of the UTC day on day 2 (21 Dec) and latest potential onset during the second half of day 3 (22 Dec). The corresponding period on the previous rotation in late November was heavily influenced by the arrival of multiple CMEs and this may have masked any connection to the coronal hole at the time. Consequently, confidence in the timing and extent of any connection to this feature is low. If it were to become geo-effective, speeds could peak between slightly elevated and strong levels. Given the coronal hole's southerly location (mainly between 30S-40S) on the disc and proximity to the solstice, any geomagnetic effects should be small with limited enhancements.

In the absence of any further coronal hole enhancement in later days, winds should trend back towards background levels.

Geomagnetic activity should remain largely Quiet to Unsettled during the period. There is a chance of peak Active conditions and a slight chance of a G1/Minor storm interval upon the arrival of the high speed stream of CH83/- days 2 or 3 (21/22 Dec).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares:

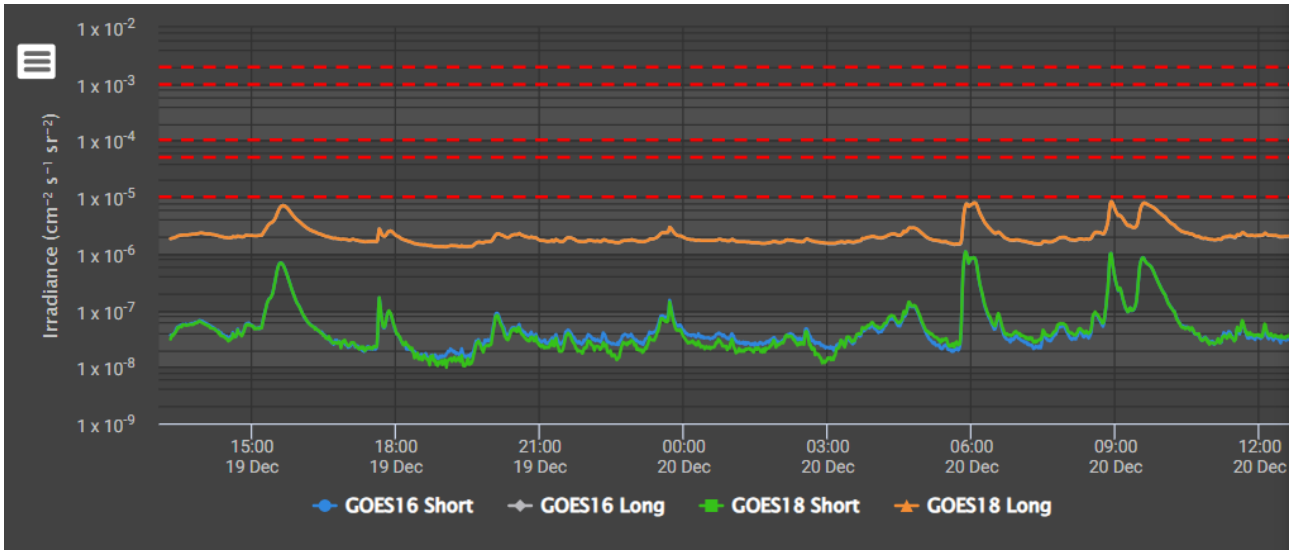
Although current activity is Low, there remains a daily chance of isolated M-class flares, mainly from AR3521, AR3528 or AR3529.

Ten sunspot regions feature on the visible disc, with two unnumbered regions recently rotated around the eastern limb, whilst AR3524 and AR3525 have faded to plage. AR3529 in the southeast is the largest spot on the disk, with continued development of both the large asymmetric leader spot and the trailing portion, now showing a beta-gamma magnetic configuration. AR3528 in the northwest is the second largest region, also exhibiting a beta-gamma magnetic structure. AR3521 in the northeast continues to develop, with some complexity to the polarity of the small intermediate spots, so a beta-gamma classification is also given to the region. The remaining regions are all smaller or magnetically simple.

No new active regions are currently expected to arrive around the eastern limb in the forecast period.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	45	45	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-ray trace



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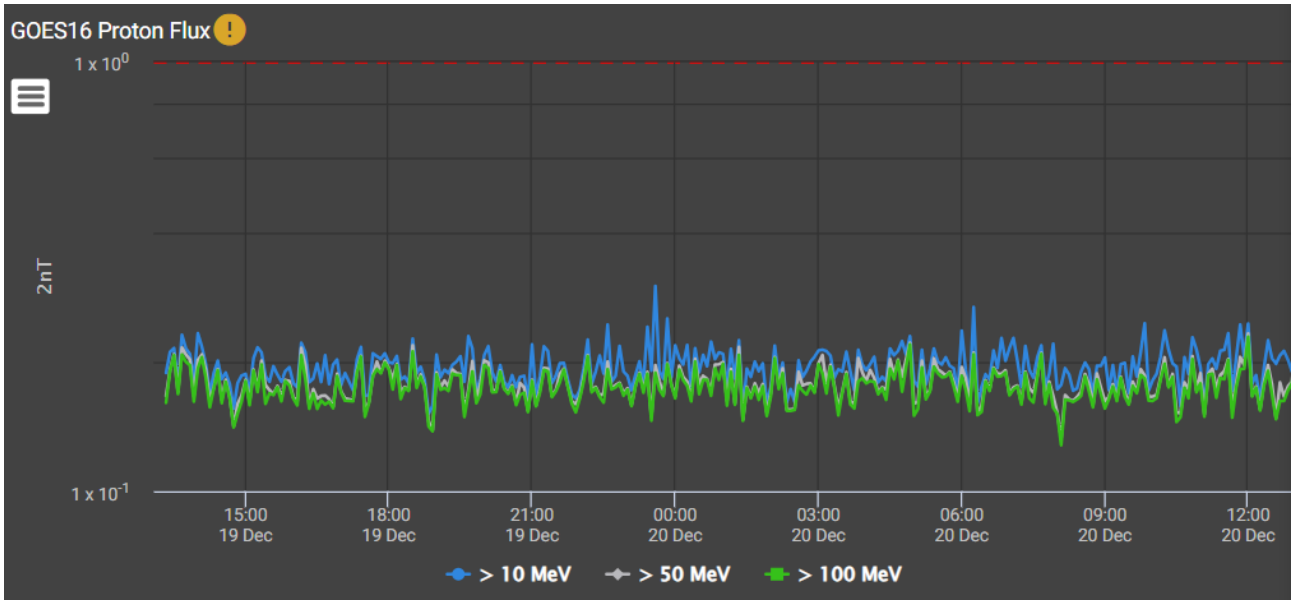
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is at normal background levels and expected to remain at similar levels unless any significant flaring occurs.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton trace



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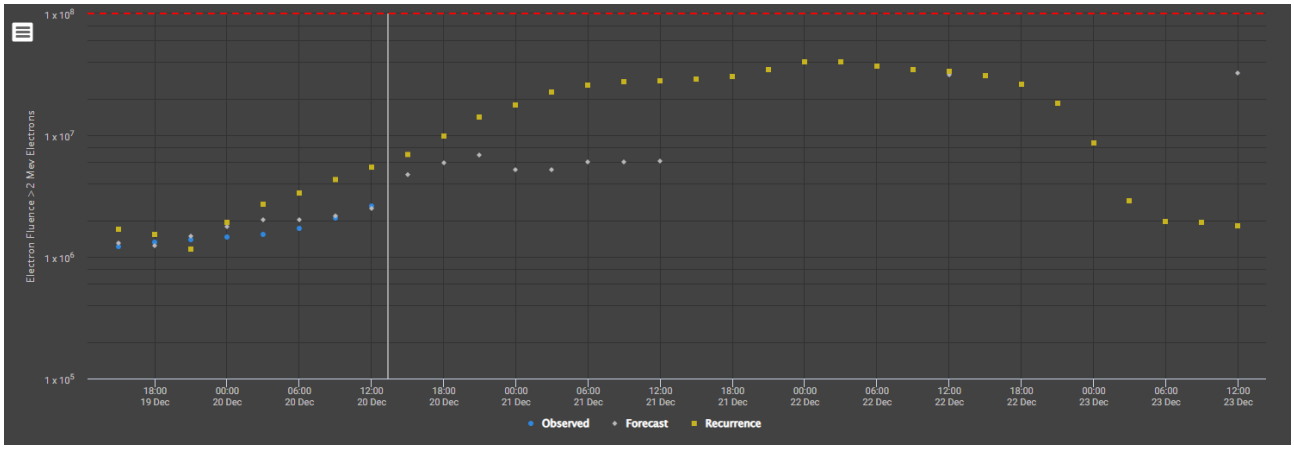
High Energy Electrons Event (≥ 2MeV):

High energy electron flux is at largely normal background levels and expected to remain so early in the period due to the ongoing, but declining fast wind from CH82/+. Daily High electron flux levels may be achieved from day 2 (21 Dec) onwards as the solar wind pressure subsides and the Van Allen belts relax towards background again. This may continue through days 3 and 4 (22-23 Dec), with a chance of more persistently High levels, however, any connection to CH83/- (low confidence) would act to suppress electrons once again to become mainly background.

There is high confidence that electron fluence will remain below the Active (1e8 integrated pfu) threshold on days 1 and 2 (20-21 Dec). From day 3 (22 Dec) onwards Active fluence is not expected, but carries low confidence, with a slight chance of exceeding threshold values.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM fluence forecast



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